WHAT IS CLAIMED IS:

1. A method for measuring a sample, comprising:

providing a beam of radiation having a polarized component, and supplying radiation from the beam to the sample;

detecting radiation from the beam that has been modified by the sample;

modulating the polarization of the beam of radiation prior to its detection by means of a rotating phase modulator and a rotating polarizer; and

deriving one or more ellipsometric parameters of the sample and one or more parameters of a system used in the providing, detecting or modulating step without restriction as to magnitude of the modulation.

2. The method of claim 1, wherein said modulating step modulates the beam before and after the beam is modified by the sample.

3. The method of claim 2, wherein said modulating step modulates the beam by rotating a first phase modulator or polarizer in an optical path of the beam before modification by the sample, and by rotating a second polarizer or phase modulator in an optical path of the beam after the beam has been modified by the sample.

4. The method of claim 3, wherein the modulating step rotates the modulator and polarizer at different speeds.

5. The method of claim 4, wherein the modulating step rotates the modulator or polarizer by more than 13 complete revolutions while the detecting step is detecting radiation from the beam.

6. The method of claim 4, wherein the modulating step rotates the modulator and polarizer at two speeds that form substantially a ratio of two integers,

wherein each of the integers is indivisible by the other, while the detecting step is detecting radiation from the beam.

7. The method of claim 3, wherein the modulating step rotates the modulator and polarizer continually, or intermittently.

8. The method of claim 7, wherein the detecting step detects said radiation during the continual rotation of the modulator and polarizer, or when the modulator and polarizer are substantially stationary when they are rotated intermittently.

9. The method of claim 1, wherein said modulating step employs a rotating polarizer, rotating retarder, PEM or Pockels cell.

10. The method of claim 9, said rotating retarder being a Fresnel rhomb.

11. The method of claim 9, wherein said deriving derives system parameters related to said rotating polarizer, rotating retarder, PEM or Pockels cell.

12. The method of claim 1, wherein said providing step includes passing unpolarized radiation through a fixed linear polarizer.

13. The method of claim 1, wherein said providing provides a beam of broadband radiation.

14. The method of claim 1, wherein radiation in said beam has wavelengths spanning a range from about 150 to about 830 nm.

15. The method of claim 1, wherein said deriving derives parameters of the system including orientation of plane of said polarized component.

16. The method of claim 1, wherein said deriving derives parameters of the system such that said ellipsometric parameters are accurately derived without calibration of the system.

17. A method for measuring a sample, comprising:

providing a beam of radiation;

passing the beam through a first fixed or rotating polarizing element so that a polarized radiation from the beam is supplied to the sample;

modulating radiation from the beam after modification by the sample by means of a rotating second rotating polarizing element to provide a modulated beam;

detecting radiation from the modulated beam;

polarizing the modulated beam before radiation from the modulated beam is detected by means of a fixed linear polarizer; and

deriving one or more ellipsometric parameters of the sample from the detected radiation.

18. The method of claim 17, further comprising rotating the first and second elements at different speeds.

19. The method of claim 18, wherein one of the two elements is rotated by more than 13 complete revolutions while the detecting step is detecting radiation from the beam.

20. The method of claim 18, wherein the two elements are rotated at two speeds that form substantially a ratio of two integers, wherein each of the integers is indivisible by the other, while the detecting step is detecting radiation from the beam.

21. The method of claim 17, wherein the two elements are rotated continually, or intermittently.

22. The method of claim 21, wherein the detecting step detects said radiation during the continual rotation of the elements, or when the elements are substantially stationary when they are rotated intermittently.

23. The method of claim 17, wherein said providing step includes passing unpolarized radiation through a fixed linear polarizer.

24. The method of claim 17, further comprising passing the modulated beam through a fixed linear polarizer before its detection.

25. The method of claim 17, wherein said providing step provides a beam of broadband radiation.

26. The method of claim 17, wherein radiation in said beam has wavelengths spanning a range from about 150 to about 830 nm.

27. The method of claim 17, said deriving step including deriving one or more parameters of the two elements, or of a system used in the providing, detecting or modulating step.

28. The method of claim 27, wherein said deriving step derives parameters of the system such that said ellipsometric parameters are accurately derived without calibration of the system or of the parameters of the two elements.

29. A method for measuring a sample, comprising:

providing a beam of radiation having a linearly polarized component and supplying radiation from the beam to the sample;

detecting radiation from the beam that has been modulated by the sample;

modulating radiation from the beam before modification by the sample but before detection by means of a rotating polarizing element;

passing the modulated radiation through a fixed or rotating linear polarizer prior to its detection; and

deriving one or more ellipsometric parameters of the sample from the detected radiation.

30. The method of claim 17, wherein the element is rotated continually, or intermittently.

31. The method of claim 30, wherein the detecting step detects said radiation during the continual rotation of the element, or when the element is substantially stationary when it is rotated intermittently.

32. The method of claim 29, wherein said providing step includes passing unpolarized radiation through a fixed linear polarizer.

33. The method of claim 29, wherein said providing step provides a beam of broadband radiation.

34. The method of claim 33, wherein radiation in said beam has wavelengths spanning a range from about 150 to about 830 nm.

35. The method of claim 29, said deriving step including deriving one or more parameters of the two elements, or of a system used in the providing, detecting or modulating step.

36. The method of claim 35, wherein said deriving step derives parameters of the system such that said ellipsometric parameters are accurately derived without calibration of the system or of the parameters of the two elements.

37. An apparatus for measuring a sample, comprising:

a source providing a beam of radiation having a linearly polarized component;

optics applying radiation from the beam to the sample;

a detector detecting radiation from the beam that has been modified by the sample;

a modulating device modulating the polarization of the beam of radiation prior to its detection, said device including a rotating phase modulator and a rotating polarizer; and

a system deriving one or more ellipsometric parameters of the sample and one or more parameters of the source, optics or modulating device without restriction as to magnitude of the phase modulation.

38. The apparatus of claim 37, wherein said modulating device includes a first phase modulator or polarizer modulating the beam of radiation prior to application of the radiation therein to the sample, and a second polarizer or phase modulator modulating the radiation from the beam after it has been modified by the sample.

39. The apparatus of claim 38, said modulating device further comprising a rotator rotating the first modulator or polarizer in an optical path of the beam before modification by the sample, and rotating the second polarizer or modulator in an optical path for radiation from the beam after it has been modified by the sample.

40. The apparatus of claim 39, wherein the rotator rotates the modulator and polarizer at different speeds.

41. The apparatus of claim 40, wherein the rotator rotates the modulator or polarizer by more than 13 complete revolutions while the detector is detecting radiation from the beam.

42. The apparatus of claim 40, wherein the rotator rotates the modulator and polarizer at two speeds that form substantially a ratio of two integers, wherein each of the integers is indivisible by the other, while the detecting step is detecting radiation from the beam.

43. The apparatus of claim 39, wherein the rotator rotates the modulator and polarizer continually, or intermittently.

44. The apparatus of claim 43, wherein the detector detects said radiation during the continual rotation of the modulator and polarizer, or when the modulator and polarizer are substantially stationary when they are rotated intermittently.

45. The apparatus of claim 39, further comprising an instrument removing or inserting one of the modulator and polarizer in an optical path of the beam of radiation between the source and the detector.

46. The apparatus of claim 37, wherein said device comprises a rotating polarizer, rotating retarder, PEM or Pockels cell.

47. The apparatus of claim 46, said rotating retarder including a Fresnel rhomb.

48. The apparatus of claim 46, wherein said system derives system parameters related to said rotating polarizer, rotating retarder, PEM or Pockels cell.

49. The apparatus of claim 37, wherein said source includes a first fixed linear polarizer.

50. The apparatus of claim 49, wherein said device includes a second fixed linear polarizer, wherein said system derives orientations of planes of said first and second linear polarizers.

51. The apparatus of claim 37, wherein said source provides a beam of broadband radiation.

52. The apparatus of claim 51, wherein radiation in said beam has wavelengths spanning a range from about 150 to about 830 nm.

53. The apparatus of claim 37, wherein said system derives parameters of the source, optics or modulating device such that said ellipsometric parameters are accurately derived without calibration of the optics or modulating device.

54. The apparatus of claim 37, further comprising an optical element diverting a portion of the radiation after modulation by the device to a position sensitive detector for sensing tilt or height of the sample.

55. The apparatus of claim 54, further comprising an objective relaying said modulated radiation from a spot on the sample illuminated by the beam to said detector, said position sensitive detector being placed at a focal length of the objective away from the objective, to detect tilt of the sample.

56. The apparatus of claim 54, further comprising an objective relaying said modulated radiation from a spot on the sample illuminated by the beam to said detector, said position sensitive detector being placed to detect the spot at a desired height of the sample.

57. The apparatus of claim 54, said optical element comprising a diffraction grating or two pellicle beam splitters.

58. The apparatus of claim 54, said optical element diverting a first portion of the radiation after modulation by the device to a first position sensitive detector for sensing tilt of the sample and a second portion of the radiation after modulation by the device to a second position sensitive detector for sensing height of the sample.

59. An apparatus for measuring a sample, comprising:

a source providing a beam of radiation;

a first fixed or rotating polarizing element modulating radiation in the beam so that polarized radiation from the beam is supplied to the sample;

a second rotating polarizing element modulating radiation from the beam after modification by the sample to provide a modulated beam;

a detector detecting radiation from the modulated beam;

a fixed linear polarizer polarizing the modulated beam before radiation from the modulated beam is detected by the detector; and

a system deriving one or more ellipsometric parameters of the sample from the detected radiation.

60. The apparatus of claim 59, said first polarizing element being a rotating polarizing element, further comprising a rotator rotating the first and second elements at different speeds.

61. The apparatus of claim 59, wherein the rotator rotates one of the two elements by more than 13 complete revolutions while the detector is detecting radiation from the beam.

62. The apparatus of claim 60, wherein the rotator rotates the two elements at two speeds that form substantially a ratio of two integers, wherein each

of the integers is indivisible by the other, while the detecting step is detecting radiation from the beam.

63. The apparatus of claim 59, further comprising a rotator rotating the two elements continually, or intermittently.

64. The method of claim 63, wherein the detector detects said radiation during the continual rotation of the elements, or when the elements are substantially stationary when they are rotated intermittently.

65. The apparatus of claim 59, wherein said source includes a fixed linear polarizer.

66. Cancelled.

67. The apparatus of claim 59, whether comprising an optical element diverting a portion of the modulated beam to a position sensitive detector for sensing tilt or height of the sample.

68. The apparatus of claim 67, said optical element comprising a diffraction grating or two pellicle beam splitters.

69. The apparatus of claim 67, said optical element diverting a first portion of the modulated beam to a first position sensitive detector for sensing tilt of the sample and a second portion of the modulated beam to a second position sensitive detector for sensing height of the sample.

70. An apparatus for measuring a sample, comprising:

a source providing a beam of radiation having a linearly polarized component;

a detector detecting radiation from the beam that has been modulated by the sample;

a rotating polarizing element modulating radiation in the beam before modification by the sample but before detection;

a fixed or rotating linear polarizer polarizing radiation modulated by the element and the sample prior to detection by the detector; and

a system deriving one or more ellipsometric parameters of the sample from the detected radiation.

71 70
76. The apparatus of claim 75, further comprising a rotator rotating the element continually, or intermittently.

72 71
77. The method of claim 76, wherein the detector detects said radiation during the continual rotation of the elements, or when the elements are substantially stationary when they are rotated intermittently.

73 70
78. The apparatus of claim 75, wherein said source includes a fixed linear polarizer.

74 70
79. The apparatus of claim 75, further comprising a fixed linear polarizer polarizing the modulated beam before radiation from the modulated beam is detected by the detector.

75 70
80. The apparatus of claim 75, wherein said source provides a beam of broadband radiation.

74 75
81. The apparatus of claim 80, wherein radiation in said beam has wavelengths spanning a range from about 150 to about 830 nm.

77 70

82. The apparatus of claim 75, said system deriving one or more parameters of the element, the polarizer or the source.

78 77

83. The apparatus of claim 82, wherein said system derives parameters of the element, the polarizer, the source and the detector such that said ellipsometric parameters are accurately derived without calibration of the two elements.

79 70

84. The apparatus of claim 75, further comprising an instrument removing or inserting one of the two elements.

80 70

85. The apparatus of claim 75, further comprising an optical element diverting a portion of the modulated beam to a position sensitive detector for sensing tilt or height of the sample.

81 80

86. The apparatus of claim 85, said optical element comprising a diffraction grating or two pellicle beam splitters.

82 80

87. The apparatus of claim 85, said optical element diverting a first portion of the modulated beam to a first position sensitive detector for sensing tilt of the sample and a second portion of the modulated beam to a second position sensitive detector for sensing height of the sample.

83

88. An apparatus for measuring a sample, comprising:

a source providing a beam of radiation;

optics applying radiation from the beam to the sample;

a detector detecting radiation from the beam that has been modified by the sample;

a modulating device modulating the beam of radiation prior to its detection; and

an optical element diverting a portion of the beam of radiation after modulation by the device to a position sensitive detector for sensing tilt or height of the sample.

~~89~~ 84. The apparatus of claim ~~88~~ 83, further comprising an objective relaying radiation modulated by the device from a spot on the sample illuminated by the beam to said detector, said position sensitive detector being placed at a focal length of the objective away from the objective, to detect tilt of the sample.

~~90~~ 85. The apparatus of claim ~~88~~ 83, further comprising an objective relaying radiation modulated by the device from a spot on the sample illuminated by the beam to said detector, said position sensitive detector being placed to detect the spot at a desired height of the sample.

~~91~~ 86. The apparatus of claim ~~88~~ 83, said optical element comprising a diffraction grating or two pellicle beam splitters.

~~92~~ 87. The apparatus of claim ~~88~~ 83, said optical element diverting a first portion of the radiation after modulation by the device to a first position sensitive detector for sensing tilt of the sample and a second portion of the radiation after modulation by the device to a second position sensitive detector for sensing height of the sample.

~~93~~ 88. An apparatus for measuring a sample, comprising:

a source providing a beam of radiation;

optics including a cylindrical objective for focusing radiation from the beam to the sample in a direction away from a normal direction to the sample;

a detector detecting radiation from the beam that has been modified by the sample;

a modulating device modulating the beam of radiation prior to its detection; and

a system deriving a reflectance or one or more ellipsometric parameters of the sample from the detected radiation.

~~94~~ 89. The apparatus of claim ~~93~~ 88, said cylindrical objective being such that radiation from the beam is focused to a substantially circular spot on the sample.

~~95~~ 90. A method for measuring a sample, comprising:

measuring the sample by means of an ellipsometer to provide first signals;

measuring the sample by means of an optical measurement instrument to provide second signals; and

deriving from information in the first and second signals one or more parameters of the sample and one or more parameters of the ellipsometer to improve accuracy of measurement.

~~96~~ 91. The method of claim ~~95~~ 90, said sample being an internal reference sample of the ellipsometer, said method further comprising calibrating the instrument using the derived parameter(s) of the sample.

~~97~~ 92. The method of claim ~~95~~ 90, wherein said instrument is a spectroreflectometer, polarimeter, or ellipsometer, said method further comprising calibrating the instrument using the derived parameter(s) of the sample.

~~98~~ 93. The method of claim ~~95~~ 90, wherein said measuring step by means of the ellipsometer includes:

providing a beam of radiation having a polarized component, and supplying radiation from the beam to the sample;

detecting radiation from the beam that has been modified by the sample;

modulating the polarization of the beam of radiation prior to its detection; and (41-50)

deriving one or more ellipsometric parameters of the sample and one or more parameters of the ellipsometer. (15-19)

94 93

~~99~~. The method of claim ~~98~~, wherein said modulating modulates the polarization of the beam of radiation without restriction as to magnitude of the modulation. (41-52)

95 90 (2-43

~~100~~. The method of claim ~~95~~, wherein said deriving derives film thickness information of the sample and depolarization of radiation caused by the sample. add (ecc 390129 (abstract)

96 95

~~101~~. The method of claim ~~100~~, said first output signals indicating sample characteristics over a spectrum of wavelengths, wherein said deriving derives depolarization of radiation caused by the sample over the spectrum.

97

~~102~~. A method for measuring a sample, comprising:

measuring the sample by means of an ellipsometer to provide first signals;

measuring the sample by means of an optical measurement instrument to provide second signals; and

deriving from the first and second signals information related to film thickness(es) of and depolarization caused by the sample. Asphest + Lee

98 97

~~103~~. The method of claim ~~102~~, further comprising, prior to measuring the sample:

measuring another sample by means of the ellipsometer to provide third signals; and

deriving from the third signals one or more parameters of the another sample and one or more parameters of the ellipsometer to calibrate the ellipsometer.

Sample measured by ellipsometer to provide signals for calibration (41-43 (58-62

(5-20

Del 6/15 Corr

99 98 dc 98

~~104~~. The method of claim ~~103~~, wherein said measuring step of another sample by means of the ellipsometer includes:

providing a beam of radiation having a polarized component, and supplying radiation from the beam to the another sample;

detecting radiation from the beam that has been modified by the another sample;

modulating the polarization of the beam of radiation prior to its detection; and

deriving one or more ellipsometric parameters of the another sample and one or more parameters of the ellipsometer.

100 99

~~105~~. The method of claim ~~104~~, wherein said modulating modulates the polarization of the beam of radiation without restriction as to magnitude of the modulation.

101 97

~~106~~. The method of claim ~~102~~, wherein said deriving also derives parameters of the ellipsometer. 16/20-30

102 97

~~107~~. The method of claim ~~102~~, said first signals indicating sample characteristics over a spectrum of wavelengths, wherein said deriving derives depolarization of radiation caused by the sample over the spectrum.

103

~~108~~. A method for measuring a sample, comprising:

measuring the sample by means of an ellipsometer to provide first signals; and

deriving from the first signals information related to film thickness(es) of and depolarization caused by the sample and one or more parameters of the ellipsometer to improve accuracy of measurement.

Attached Sheet 915 Corr

104 103
~~109~~. The method of claim ~~108~~, wherein said measuring step by means of the ellipsometer includes:

providing a beam of radiation having a polarized component, and supplying radiation from the beam to the sample;

detecting radiation from the beam that has been modified by the sample;

modulating the polarization of the beam of radiation prior to its detection; and

deriving one or more ellipsometric parameters of the sample and one or more parameters of the ellipsometer.

105 104
~~110~~. The method of claim ~~109~~, wherein said modulating modulates the polarization of the beam of radiation without restriction as to magnitude of the modulation.

106 103
~~111~~. The method of claim ~~108~~, said first output signals indicating sample characteristics over a spectrum of wavelengths, wherein said deriving derives depolarization of radiation caused by the sample over the spectrum.

107
~~112~~. An apparatus for measuring a sample, comprising:

an ellipsometer measuring the sample to provide first signals;

an optical measurement instrument measuring the sample to provide second signals; and

a system deriving from information in the first and second signals one or more parameters of the sample and one or more parameters of the ellipsometer to improve accuracy of measurement.

108 107
~~113~~. The apparatus of claim ~~112~~, said sample being an internal reference sample of the ellipsometer.

109 107
~~114~~. The apparatus of claim ~~112~~, wherein said instrument is a spectroreflectometer, polarimeter, or ellipsometer, wherein said sample is also a calibration sample of the instrument.

110 107
~~115~~. The apparatus of claim ~~112~~, wherein said ellipsometer includes:

a source providing to the sample a beam of radiation having a polarized component; see 98

a detector detecting radiation from the beam that has been modified by the sample to provide an output;

a modulator modulating the polarization of the beam of radiation prior to its detection; and

a processor deriving from the output one or more ellipsometric parameters of the sample and one or more parameters of the ellipsometer.

111 110
~~116~~. The apparatus of claim ~~115~~, wherein said modulator modulates the polarization of the beam of radiation without restriction as to magnitude of the modulation.

112 110
~~117~~. The apparatus of claim ~~115~~, wherein said processor derives film thickness information of the sample and depolarization of radiation caused by the sample.

113 112
~~118~~. The apparatus of claim ~~117~~, said first output signals indicating sample characteristics over a spectrum of wavelengths, wherein said processor derives depolarization of radiation caused by the sample over the spectrum.

114
~~119~~. An apparatus for measuring a sample, comprising:

an ellipsometer measuring the sample to provide first signals;

an optical measurement instrument measuring the sample to provide second signals; and

a system deriving from the first and second signals information related to film thickness(es) of and depolarization caused by the sample.

115 114
~~120~~. The apparatus of claim ~~119~~, wherein said ellipsometer includes:

a source providing a beam of radiation having a polarized component to the sample;

a detector detecting radiation from the beam that has been modified by the sample;

a modulator modulating the polarization of the beam of radiation prior to its detection; and

a processor deriving one or more ellipsometric parameters of the sample and one or more parameters of the ellipsometer.

116 115
~~121~~. The apparatus of claim ~~120~~, wherein said modulator modulates the polarization of the beam of radiation without restriction as to magnitude of the modulation.

117 114
~~122~~. The apparatus of claim ~~119~~, wherein said deriving means derives parameters related to the ellipsometer.

118 117
~~123~~. The apparatus of claim ~~122~~, said first output signals indicating sample characteristics over a spectrum of wavelengths, wherein said deriving means derives depolarization of radiation caused by the sample over the spectrum.

119
~~124~~. An apparatus for measuring a sample, comprising:

an ellipsometer measuring the sample to provide first signals; and

a system deriving from the first signals information related to film thickness(es) of and depolarization caused by the sample and one or more parameters of the ellipsometer to improve accuracy of measurement.

125. The apparatus of claim 124, wherein said ellipsometer includes:

a source providing a beam of radiation having a polarized component to the sample;

a detector detecting radiation from the beam that has been modified by the sample;

a modulator modulating the polarization of the beam of radiation prior to its detection; and

a processor deriving one or more ellipsometric parameters of the sample and one or more parameters of the ellipsometer.

126. The apparatus of claim 125, wherein said modulator modulates the polarization of the beam of radiation without restriction as to magnitude of the modulation.

127. The apparatus of claim 124, said first output signals indicating sample characteristics over a spectrum of wavelengths, wherein said deriving means derives depolarization of radiation caused by the sample over the spectrum.

128. A method for measuring a sample, comprising:

measuring the sample by means of an ellipsometer supplying radiation to the sample and detecting said radiation after modification by the sample to provide first signals, wherein said measuring includes modulating the radiation supplied to the sample at a frequency by means of a rotating polarizer, said first signals including components at more than five harmonics of said frequency; and

deriving from the first signals information related to film thickness(es) of and depolarization caused by the sample.

129. An apparatus for measuring a sample, comprising:

an ellipsometer measuring the sample to provide output signals; and

a system deriving from the signals information related to film thickness(es) of and depolarization caused by the sample, said ellipsometer comprising at least one rotating polarizer.

125

~~120~~. An apparatus for measuring a sample, comprising:

an ellipsometer measuring the sample to provide output signals; and

a system deriving from the signals information related to film thickness(es) of and depolarization caused by the sample, said ellipsometer comprising:

a source supplying radiation having a polarized component in a first optical path to the sample;

a first phase modulator in the first optical path modulating the phase of the polarized component;

a detector detecting radiation along a second optical path, where the radiation detected by the detector is supplied by the source and modified by the sample; and

a second phase modulator in the second optical path modulating the phase of the polarized component.